FINAL

**VEHICLE REGISTRATION RECORDS ANALYSIS AND MODEL YEAR
DISTRIBUTION
REPORT**

GEORGIA INSTITUTE OF TECHNOLOGY

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I. Introduction

The following section provides an overview of the project, a historical background, and the project objectives.

Project Overview

The objective of the study is to provide the Air Protection Branch of the Georgia Department of Natural Resources (DNR) with age distributions for several vehicle fleets within the State of Georgia. The data will serve as input into the U.S. Environmental Protection Agency's MOBILE5b model, used to estimate mobile source emissions in the State of Georgia. The research task will involve extracting data from the 1999 Georgia Vehicle Registration Database and coding that data to match six vehicle categories used by MOBILE5b.

MOBILE5b uses the vehicle fleet distribution which is defined as the fraction of the fleet that falls into each of 25 age groups to determine aggregate fleet emissions for a given geographic area. Individual emission factors are applied to vehicles by vehicle age, which are extrapolated to the fleet at large via the vehicle fleet distribution. An accurate vehicle fleet distribution is key to the validity of the emissions inventory because emissions increase with vehicle age. Thus a vehicle distribution that overestimates newer vehicles will also underestimate aggregate emissions. There is potential for mobile source inventory inaccuracies if outdated fleet information is used.

Historical Background

Prior to this project, the most recent distribution was generated by DNR based on State of Georgia vehicle registration records from 1990. That approach used a combination of automobile inspection/maintenance records, registration records, and MOBILE5b model default values. In contrast, the approach reported here relies chiefly on unique information encoded in the Vehicle Identification Number (VIN), as well as other key information, from the 1999 Vehicle Registration Database for the State of Georgia.

Project Objectives

The objective is to generate fleet age distributions for 1999 by coding vehicle characteristics provided by vehicle registration data to match the categories needed by the MOBILE5b model. The general approach involves designating vehicles in the registration data to MOBILE5b categories using weight, fuel type, and general vehicle type (Table I).

The characteristics vehicle "Type" and weight, known as Gross Vehicle Weight Rating (GVWR), are derived by decoding the VIN, a 17-character string embedded with codes representing vehicle specifications. The VINs are decoded using a Radian VIN decoder software package used by mobile source researchers to obtain detailed vehicle attributes.

Table I. Vehicle Classification Scheme for MOBILE5b Categories

	GVWR	VINTYPE	FUEL
LDGV	-NA-	CAR	Gasoline
LDGT1	0 - 6000 pounds	TRK or MPV or VAN	Gasoline
LDGT2	6001 - 8500 pounds	TRK or MPV or VAN	Gasoline
HDGV	>8500 lbs.	TRK or MPV or VAN	Gasoline
LDDV	-NA-	CAR	Gasoline[1]
LDDT	0 - 8500 pounds	TRK or MPV or VAN	Gasoline[2]
HDDV	>8500 lbs.		Diesel
MC	-NA-	MOTORCYCLE	Gasoline

1. MOBILE5b designates the fraction of diesel versus gasoline vehicles for this category; consequently, the LDGV registration distribution is combined with the distribution for LDDVs.
2. MOBILE5b designates the fraction of diesel versus gasoline vehicles for this category; consequently, the LDGT1 registration distribution is combined with the distribution for LDDTs.

Once the categorization process is completed, the data is tabulated and entered into an Excel spreadsheet to determine the relative frequency of each of the 25 model years for six categories of vehicles. The spreadsheet calculates the fractional distribution and ensures that each of the fractional distributions, when summed together, equal one, per the input requirements of MOBILE5b.

II. Process Description

The following describes the process used in the generation of the fractional distribution for each of the six categories of vehicles used by the MOBILE5b Model.

Data Reduction

The first step in the process was to reduce the amount of data in the working database to include only the thirteen counties that comprise the metro Atlanta non-attainment area. This first step reduced the number of records from 8.5 million records contained in the 1999 registration database to 3.5 million records The primary goal was to increase overall efficiency of the project development. The resulting table was named "Thirteenco". The Thirteenco table was further reduced to contain the key fields VIN, Make, Model Year, and Fuel. These data constitute the new table "Thirteenfuel". In short, the first step was to reduce the total number of records such that the new table contained only 13-county records. The second step was intended to reduce the number of fields to include only those fields that were essential to the project development. Appendix A, provides the Sequential Query Language (SQL) code used in the development of each of the tables mentioned in this report.

VIN Extraction and Decoding

Approximately 3.5 million VINs were extracted from the Thirteenco Table. This data was exported as an ASCII file for input into a software program known as the Radian VIN Decoder, Version: 98.01, May 18, 1999. The VIN decoder is important because it was the only reliable means by which the key data elements vehicle TYPE and GVWR can be obtained. Because four out of six of the distributions involve the differentiation of trucks based on GVWR, the VIN decoder became an essential part of the overall effort.

The output from the VIN decoder suggested that 93.5 percent of the VINs were decoded without error. The decoder produces a table in ASCII text, which was then imported into an Oracle database for further processing. This table was reduced to the following key fields: VINType or vehicle "TYPE" and "GVWR". Additional support fields include VIN, VINYear, VINMake, VINSeries (essentially vehicle model), and VINBody, and VINManuf (Manufacturer). Those key fields TYPE and GVWR, along with the support fields, constitute the new table named "13VINs". The additional fields were included for quality control purposes. The section entitled "Quality Assurance/Quality Control (QA/QC)" provides additional detail regarding the quality control process.

Generating the Project table "MOBILE"

The table 13VINS was then merged with the Thirteenfuel table to produce the table MOBILE which contains the key data fields Fuel, Model Year, Type, and GVWR. This table provided the basis for the rest of the project. Both the passenger car and truck tables were derived from this table.

As was indicated in Section I, Project Objectives, the truck categories were defined based on TYPE and GVWR. It is important to point out, that the VIN decoder produces 4 categories of trucks and 38 categories for GVWR Each of these conditions had to be accounted for in the generation of every table that involved trucks. Appendix A provides the Sequential Query Language (SQL) code used to define these categories.

Generating the "All Trucks" Table

The next step in the process was to generate a master truck table called "All Trucks". This table was derived the MOBILE table and included all of the records that qualified under the "truck" definition (Figure 1). The following are truck tables derived tables from the All Trucks table:

1. Diesel Trucks – this table is limited to trucks that are powered by diesel fuel.
2. LDDT - Light Duty Diesel Trucks derived from the Diesel Trucks table.
3. HDDV – Heavy Duty Diesel Trucks derived from the Diesel Trucks table.
4. Gas Trucks – This table includes all the trucks powered by gasoline.
5. LDGT1 – this table is derived from the Gas Trucks Table
6. LDGT2 Table – this table is derived from the Gas Trucks Table
7. HDGT Table – this table is derived from the Gas Trucks Table

As indicated previously, the derived tables are the tables use to generate the Excel spreadsheet distributions. The process involved running queries based on model year against each of the tables and recording the number of records selected for that year.

Generating the Passenger Car (LDGV/LDDV) and Motorcycle Distributions

The process for generating a distribution for the passenger car category (LDGV/LDDV) was less complex because it did not require consideration for GVWR. The only VIN decoded required fields were vehicle TYPE. The fields Model Year and Fuel were derived from the registration data.

The distribution for the motorcycle category included motorcycles, mopeds, motorized bikes, and motor scooters. Because these data were well defined in the registration database and did not have a dependency on GVWR, this category was extracted directly from the registration data.

A copy of the Excel spread sheets containing the frequency and fractional distributions can be found in Appendix B.

FIGURE 1
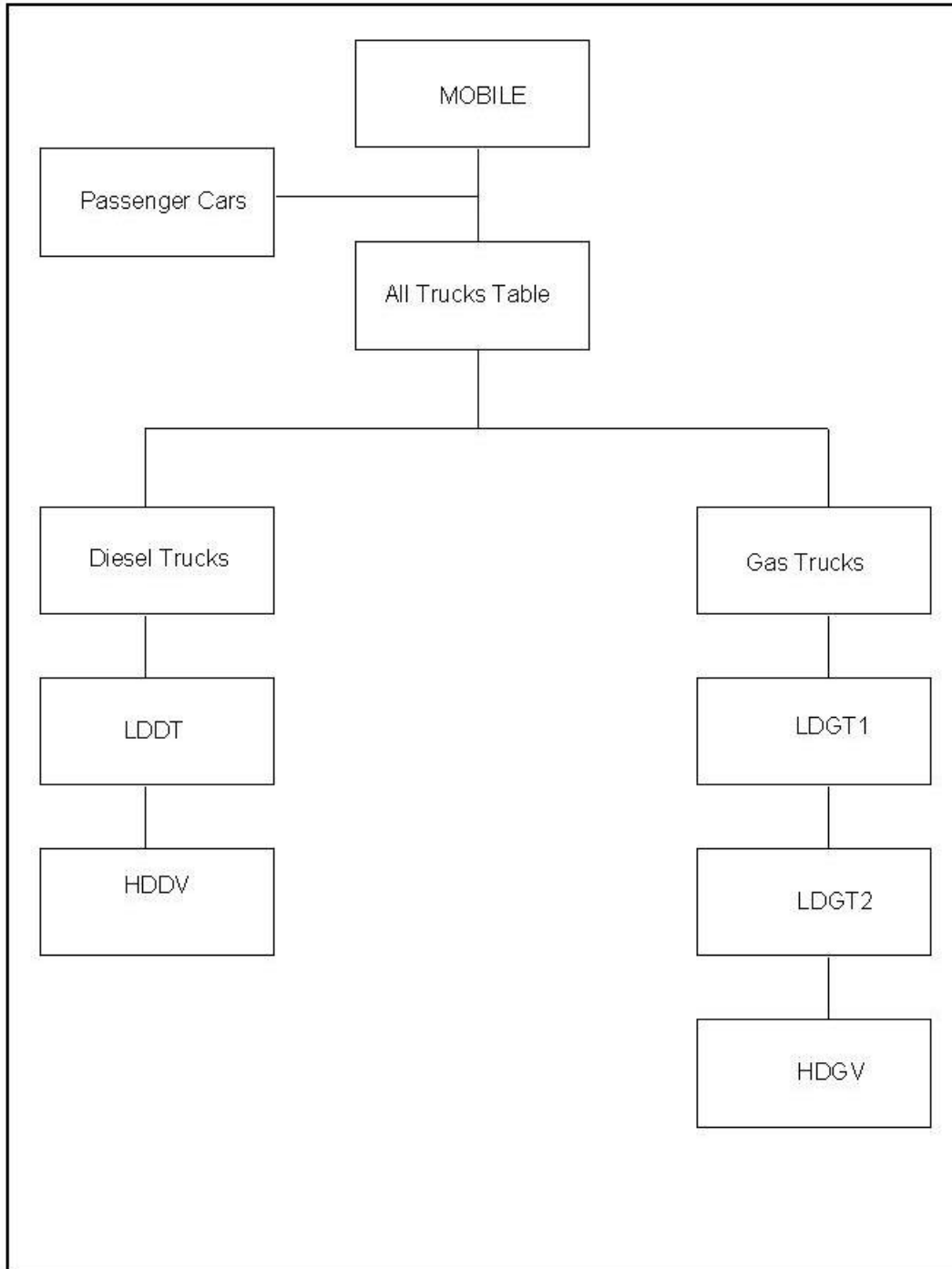
Figure 1 Illustrates the development of the various of the passenger cars and the development of "Trucks" tables from the project table MOBILE

Quality Assurance/Quality Control (QA/QC)

The goal of the QA/QC effort was to build quality assurance checks into each phase of data reduction and manipulation. Because of the project's complexity, relying solely on a post-data reduction inspection process would have been difficult to implement. Instead, each query was spot checked to ensure production of the desired results. For example, a query that determines the frequency of record occurrence for LDDTs in 1999, the resulting table should have only "1999" in the Model Year field and only the letter "D" in the Fuel field to designate diesel.

As indicated in Process Description, Section C, the design for the table MOBILE included "support fields" or fields that contain redundant information for the purpose of quality control. In the case of the MOBILE table, the fields VIN, VINYear, VINMake, VINSeries, VINBody, and VINManuf were included to allow for immediate checking between the results of the VIN decoder and the fields Make, Model, and Model Year from the registration data.

Other quality control measures included the spreadsheet design. The spreadsheet displays the frequency results for each model year along with the fractional results for easier tracking and checking. In addition, the spreadsheet ensured that all of the fractional values for each category summed to one.

Graphing the results of the fractional values in the spreadsheet against vehicle age in model years, allowed for the visual inspection of the data to determine if anomalous results were present.

III. Conclusions and Recommendations

This section provides a summary of the conclusions resulting from the project and a description of the recommendations for improving work on future projects.

<u>Conclusions</u>

The generation of vehicle distributions by age and by type is not an "exact science" for several reasons. The registration database produced by the Georgia Department of Revenue is oriented toward determining tax revenue rather than potential mobile emissions. For example, the registration database divides trucks into 23-categories based on their function or purpose (e.g. armored car, cement mixer, dump truck, bottle rack, etc.). Clearly, the motivation for this type and level of classification is to determine the tax revenue due the state. Of the 49 fields contained in the registration database, 18 of those fields are exclusively tax related.

As indicated previously, the VIN decoder indicated an error rate of 6.5%. It is important to mention that most of these errors occurred for model years older than 1984 and may create a bias in the data for these early years. This is due to a lack of standardized VIN assignments in the automotive industry during those early years. Eventually (circa 1986) the industry standardized on a 17-alphanumeric coding scheme, however differences between some manufacturer methodologies for coding still exist.

A comparison between registration data and the results of the VIN decoder was made to further define the limitations of the VIN decoder. While initiated for the purpose of QA/QC, this effort revealed some additional limitations to generating distributions using VIN decoding. There are almost no means of accounting for the effects of "after-market" modifications to vehicles. An example would include the modification of a standard family minivan transformed into an armored car. The VIN number assigned to the chassis of the vehicle decodes as standard minivan while the registration data describes the vehicle as an armored truck. A similar condition occurs when van is converted to an "airport shuttle". The vehicle decodes as a van but by the time it becomes registered in the state – it's a "bus" and the GVWR generated by the VIN decoder is probably only half the actual GVWR for the vehicle on the road.

The automobile industry is not committed to providing consistent naming conventions to their model line over a 25-year period. It was difficult at times to determine whether a vehicle produced by the same manufacturer within a five-model year window was a truck, a van, a bus, or a minivan. This blurring of classifications led to a further reliance on the VIN decoder and a greater realization that the generating of vehicle distributions over a 25-year span has some inherent limitations.

Registration databases typically contain an irreducible number of errors due to data entry mistakes and improper maintenance. In this case, VIN decoding provides some advantages because it uses a decoding process and bypasses data entry errors. Moreover,

decoding is virtually the only practical means of comparing motor vehicle data between states.

Excel charts were generated for each of the distributions along with the distributions for the aforementioned 1990 registration data. The general shape of the distributions suggests that the maximum frequency for a given vehicle group occurs around 4 to 5 years of age followed by a steep decline. A less pronounced increase in frequency occurs between ages 12 to 15 years old suggesting that this group consist of "survivors" that remains on the road. A spike generally occurs at model year 1975 because this age category contains both model year 1975 and older vehicles. A copy of these charts can be found in Appendix C.

In summary, vehicle registration databases are often designed for a purpose that is tangential, at best, to the needs of emissions modeling. The use of the VIN decoder is limited by inconsistencies in the automobile industry and after-market changes to vehicles, which produce an additional level of complexity that is difficult to quantify. However, it is interesting to note that, in spite of these challenges, the distributions generated with the 1990 model year data tracked closely with the 1999 data. This suggests that the methodology described herein may provide a reasonable representation of fleet for model year 1999. Moreover, the use of the VIN decoder in conjunction with the registration database may be the only practical approach to generating distributions suitable for input into the MOBILE5b model at this time.

Recommendations

The difficulties described in the current effort could be mitigated considerably with the use of the Department of Revenue's new GRATIS program, which is used to maintain statewide vehicle registration records. The new system includes a field for vehicle weight (GVWR) and this could at least reduce the need for a VIN decoder and some of its associated deficiencies. As of this writing, the format and condition of this data are unknown.

Should the GVWR data contained in GRATIS prove to be unusable, then it must be determined if the current methodology produces an adequate level of detail. Also, a determination should be made regarding amount of detail needed for future versions of MOBILE.

If it is determined that a greater effort is needed to more accurately reflect the fleet, then consideration should be given to developing a customized VIN decoder. A new decoder could be developed that would be more closely tied to the data definitions being used in the GRATIS program. Improvements to the current decoder might include the use of heuristics to determine weight classifications for some trucks older that the mid-1980s. For example, the decoder could be designed such that a failure to properly decode the weight for a cement mixer would still allow the software to assign a GVWR value to be greater than 8500 pounds. This simple substitution could help capture data that is

currently lost to a one-step process that depends exclusively on data encoded into the VIN.

IV. Appendix

The following is a listing of the items contained in the appendix.

A. The Sequential Query Language (SQL) code used to generate the tables identified in the report as well as the various data elements used to define the "Truck" category

B. A copy of the Microsoft Excel spreadsheet used in the generation of the distributions

C. This section includes copies of the Microsoft Excel charts described in the section on Quality Control

The following outlines the table development and QA/QC procedures, used in the generation of vehicle distributions for input into MOBILE5. This section corresponds to "Section II. Process Description" in the body of the report.

1. Reduce the DMV registration database, RegMid99 to the thirteen county non-compliance area

```
CREATE table thirteenCO
     as
     select modelyear, body from regmid99
     where countycode = '35' or
     countycode = '13' or
     countycode = '7' or
     countycode = '27' or
     countycode = '2' or
     countycode = '112' or
     countycode = '1' or
     countycode = '16' or
     countycode = '54' or
     countycode = '79' or
     countycode = '75' or
     countycode = '89' or
     countycode = '57';
     [GOOD]
```

QA/QC: records in line with expectations ~ 3.5 million

2. Generate VINs table for decoding by selecting only VINs from the ThirteenCO table

```
     Selected    3,518,326 VIN Records
     Decoded     3,518,326 VIN records

     Number records where decoder reported an error 228,793 (6.5%)

     Number of records older than 1984 = 467,919 (13.2% of total
     thirteen counties)
```

Note: Need "Type" and "GVWR" from VIN decoder, need "Fuel Type" and "Modelyear" from registration data. Additional rows selected for QA/QC.

Create table "Thirteenfuel" from registration data to reduce the table "ThirteenCO" for fuel and model year.

QA/QC
Record Tally Check
Record Count Table ThirteenCO = 3,518,451
Record Count Table VINData   = 3,518,216 (22 Oracle Rejects)
Record Count Table Thirteenfuel   = 3,518,479

SELECTION FOR LIGHT DUTY GAS AND DIESEL CARS

```
select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR';

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1999;

select make, modelyear, fuel, vinyear, vinmanuf, gvwr from
thirteenfuel, vindata
where VIN = VINVIN and vintype = 'CAR' and modelyear = 1998;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1997;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1995;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1994;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1993;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1992;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1991;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1990;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1989;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1988;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1987;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1986;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1985;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1984;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1983;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1982;
```

```
select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1981;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1980;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1979;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1978;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1977;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1976;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear = 1975;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='CAR' and modelyear <= 1975;

Result: 2,106,875
```

ESTABLISH DEFINITIONS FOR TRUCKS

```
Select VINmake, VINseries, VINBody, VinType, vinyear,GVWR from vindata
where vintype ='MPV' or
vintype = 'TRK' or
vintype = 'VAN';
```

QA/QC – Determine how VIN decoder identifies trucks
```
select vintype from vindata where
vintype <> 'TRK' and
vintype <> 'VAN' and
vintype <> 'MPV' and
vintype <> 'CAR' and
vintype <> 'INC' and
vintype <> 'BUS';
[Found INC – 88,882 records]
[Found BUS – 14,984 records]
```

Upshot: expand the "truck" definition to include
INC and BUS.

Notes: Chrysler Ram wagon is considered a 'BUS'.

QA/QC Establish Definition for GVWR - Determine how the VIN decoder
expresses weight. By process of elimination find any weight categories
that are NOT part of the following:

```
select gvwr from vindata where
gvwr <> '0- 3000' and
gvwr <> '0- 3500' and
gvwr <> '0- 3750' and
gvwr <> '0- 3900' and
gvwr <> '0- 4200' and
gvwr <> '0- 5000' and
gvwr <> '0- 5400' and
gvwr <> '0- 6000' and
gvwr <> '0- 6025' and
gvwr <> '0- 6200' and
gvwr <> '0- 6225' and
gvwr <> '0- 8000' and
gvwr <> '3001- 4000' and
gvwr <> '4001- 5000' and
gvwr <> '5001- 6000' and
gvwr <> '6001- 7000' and
gvwr <> '6001- 8500' and
gvwr <> '6001- 7000' and
gvwr <> '6001- 8500' and
gvwr <> '6000-10000' and
gvwr <> '6500- 8500' and
gvwr <> '7001- 8000' and
gvwr <> '8001- 8500' and
gvwr <> '8001- 9000' and
gvwr <> '8501- 9000' and
gvwr <> '8501-10000' and
gvwr <> '9001-10000' and
gvwr <> '10000-11000' and
gvwr <> '10001-11000' and
gvwr <> '10000-14000' and
gvwr <> '10001-14000' and
gvwr <> '14001-16000' and
gvwr <> '16001-19000' and
gvwr <> '16001-19500' and
gvwr <> '19001-26000' and
gvwr <> '19501-26000' and
gvwr <> '26001-33000' and
gvwr <> '33001-40000';
```

Upshot: the VIN decoder is capable of generating 37 GVWR
classifications, each of which will be employed in the generation of
the "truck" tables and distributions.

The following queries are intended to generate individual tables for each type of truck category or distribution. This very methodical approach was selected to reduce the potential of generating incorrect data due to complex queries and to simplify the QA/QC process.

Create the **ALL TRUCKS** Table

```
SELECT Mobile.VIN, Mobile.Make, Mobile.ModelYear, Mobile.Fuel,
Mobile.VINVIN, Mobile.VINYear, Mobile.VINMake, Mobile.VINSeries,
Mobile.VINBody, Mobile.VINmanuf, Mobile.VINType, Mobile.GVWR INTO [All
Trucks]
FROM Mobile
WHERE (((Mobile.VINType)='TRK' Or (Mobile.VINType)='VAN' Or
(Mobile.VINType)='MPV' Or (Mobile.VINType)='INC' Or
(Mobile.VINType)='BUS'));
```

Result: 1,101,335 records
            197,848 records NULL GVWR

Generate the **DIESEL TRUCKS** Table

```
SELECT [All Trucks].VIN, [All Trucks].Make, [All Trucks].ModelYear,
[All Trucks].Fuel, [All Trucks].VINVIN, [All Trucks].VINYear, [All
Trucks].VINMake, [All Trucks].VINSeries, [All Trucks].VINBody, [All
Trucks].VINmanuf, [All Trucks].VINType, [All Trucks].GVWR INTO [Diesel
Trucks]
FROM [All Trucks]
WHERE ((([All Trucks].Fuel)='D'));
```

Result: 32,510 records
            17,398 records NULL GVWR

Generating the **GAS TRUCKS** Table From All TRUCKS

```
SELECT [All Trucks].VIN, [All Trucks].Make, [All Trucks].ModelYear,
[All Trucks].Fuel, [All Trucks].VINVIN, [All Trucks].VINYear, [All
Trucks].VINMake, [All Trucks].VINSeries, [All Trucks].VINBody, [All
Trucks].VINmanuf, [All Trucks].VINType, [All Trucks].GVWR INTO [Gas
Trucks]
FROM [All Trucks]
WHERE ((([All Trucks].Fuel)='G'));
```

Result: 1,023,115 records

Create the **Light Duty Diesel Truck (LDDT)** Table [Types 1 & 2]

SELECT [Diesel Trucks].VIN, [Diesel Trucks].Make, [Diesel
Trucks].ModelYear, [Diesel Trucks].Fuel, [Diesel Trucks].VINVIN,
[Diesel Trucks].VINYear, [Diesel Trucks].VINMake, [Diesel
Trucks].VINSeries, [Diesel Trucks].VINBody, [Diesel Trucks].VINmanuf,
[Diesel Trucks].VINType, [Diesel Trucks].GVWR
FROM [Diesel Trucks]
WHERE (((([Diesel Trucks].GVWR)='0- 3000')) OR (((([Diesel
Trucks].GVWR)='0- 3500')) OR (((([Diesel Trucks].GVWR)='0- 3750')) OR
(((([Diesel Trucks].GVWR)='0- 3900')) OR (((([Diesel Trucks].GVWR)='0-
4200')) OR (((([Diesel Trucks].GVWR)='0- 5000')) OR (((([Diesel
Trucks].GVWR)='0- 5400')) OR (((([Diesel Trucks].GVWR)='0- 6000')) OR
(((([Diesel Trucks].GVWR)='0- 6025')) OR (((([Diesel Trucks].GVWR)='0-
6200'))OR (((([Diesel Trucks].GVWR)='0- 6225')) OR (((([Diesel
Trucks].GVWR)='0- 8000')) OR (((([Diesel Trucks].GVWR)='3001- 4000'))
OR (((([Diesel Trucks].GVWR)='4001- 5000')) OR (((([Diesel
Trucks].GVWR)='5001- 6000')) OR (((([Diesel Trucks].GVWR)='6001-
7000'))   OR (((([Diesel Trucks].GVWR)='6001- 8500')) OR (((([Diesel
Trucks].GVWR)='6001- 7000')) OR (((([Diesel Trucks].GVWR)='6001- 8500'))
OR (((([Diesel Trucks].GVWR)='6500- 8500')) OR (((([Diesel
Trucks].GVWR)='7001- 8000')) OR (((([Diesel Trucks].GVWR)='6001- 7000'))
OR (((([Diesel Trucks].GVWR)='8001- 8500'));

Result: 3095 records

Generate the **Light Duty Gas Trucks (LDGT1**) Table
SELECT [Gas Trucks].VIN, [Gas Trucks].Make, [Gas Trucks].ModelYear,
[Gas Trucks].Fuel, [Gas Trucks].VINVIN, [Gas Trucks].VINYear, [Gas
Trucks].VINMake, [Gas Trucks].VINSeries, [Gas Trucks].VINBody, [Gas
Trucks].VINmanuf, [Gas Trucks].VINType, [Gas Trucks].GVWR INTO LDGT1
FROM [Gas Trucks]
WHERE (((([Gas Trucks].GVWR)='0- 3000' Or ([Gas Trucks].GVWR)='0- 3500'
Or ([Gas Trucks].GVWR)='0- 3750' Or ([Gas Trucks].GVWR)='0- 3900' Or
([Gas Trucks].GVWR)='0- 4200' Or ([Gas Trucks].GVWR)='0- 5000' Or ([Gas
Trucks].GVWR)='0- 5400' Or ([Gas Trucks].GVWR)='0- 6000' Or ([Gas
Trucks].GVWR)='3001- 4000' Or ([Gas Trucks].GVWR)='4001- 5000' Or ([Gas
Trucks].GVWR)='5001- 6000'));

Result: 593,586 records

Create the **LDGT1/LDDT** table by appending the LDGT1 into the LDDT table.
This done buy first creating a copy of LDDT and renaming the copy
"LDGT1_LDDT"

INSERT INTO LDGT1_LDDT (VIN, Make, ModelYear, Fuel, VINVIN, VINYear,
VINMake, VINSeries, VINBody, VINmanuf, VINType, GVWR)
SELECT LDGT1.VIN, LDGT1.Make, LDGT1.ModelYear, LDGT1.Fuel,
LDGT1.VINVIN, LDGT1.VINYear, LDGT1.VINMake, LDGT1.VINSeries,
LDGT1.VINBody, LDGT1.VINmanuf, LDGT1.VINType, LDGT1.GVWR
FROM LDGT1;

Result: 598,821 records

Generating the **DISTRIBUTION for LDGT1/LDDT**
SELECT LDGT1_LDDT.VIN, LDGT1_LDDT.Make, LDGT1_LDDT.ModelYear,
LDGT1_LDDT.Fuel, LDGT1_LDDT.VINVIN, LDGT1_LDDT.VINYear,
LDGT1_LDDT.VINMake, LDGT1_LDDT.VINSeries, LDGT1_LDDT.VINBody,
LDGT1_LDDT.VINmanuf, LDGT1_LDDT.VINType, LDGT1_LDDT.GVWR
FROM LDGT1_LDDT
WHERE (((LDGT1_LDDT.ModelYear)<=1975));
Vintype 'INC' = 88,632
and modelyear = 1999

Create Table **HDGV**
SELECT [Gas Trucks].VIN, [Gas Trucks].Make, [Gas Trucks].ModelYear,
[Gas Trucks].Fuel, [Gas Trucks].VINVIN, [Gas Trucks].VINYear, [Gas
Trucks].VINMake, [Gas Trucks].VINSeries, [Gas Trucks].VINBody, [Gas
Trucks].VINmanuf, [Gas Trucks].VINType, [Gas Trucks].GVWR INTO [Make
HDGV Table]
FROM [Gas Trucks]
WHERE (((([Gas Trucks].GVWR)='8501- 9000' Or ([Gas Trucks].GVWR)='8501-
10000' Or ([Gas Trucks].GVWR)='9001-10000' Or ([Gas
Trucks].GVWR)='10000-11000' Or ([Gas Trucks].GVWR)='10001-11000' Or
([Gas Trucks].GVWR)='10000-14000' Or ([Gas Trucks].GVWR)='10001-14000'
Or ([Gas Trucks].GVWR)='14001-16000' Or ([Gas Trucks].GVWR)='16001-
19000' Or ([Gas Trucks].GVWR)='16001-19500' Or ([Gas
Trucks].GVWR)='19001-26000' Or ([Gas Trucks].GVWR)='19501-26000' Or
([Gas Trucks].GVWR)='26001-33000' Or ([Gas Trucks].GVWR)='33001-
40000'));
Result: 50,042

Create Table **HDDV**
SELECT [Diesel Trucks].VIN, [Diesel Trucks].Make, [Diesel
Trucks].ModelYear, [Diesel Trucks].Fuel, [Diesel Trucks].VINVIN,
[Diesel Trucks].VINYear, [Diesel Trucks].VINMake, [Diesel
Trucks].VINSeries, [Diesel Trucks].VINBody, [Diesel Trucks].VINmanuf,
[Diesel Trucks].VINType, [Diesel Trucks].GVWR INTO HDDV
FROM [Diesel Trucks]
WHERE (((([Diesel Trucks].GVWR)="8501- 9000'" Or ([Diesel
Trucks].GVWR)='8501-10000' Or ([Diesel Trucks].GVWR)='9001-10000' Or
([Diesel Trucks].GVWR)='10000-11000' Or ([Diesel Trucks].GVWR)='10001-
11000' Or ([Diesel Trucks].GVWR)='10000-14000' Or ([Diesel
Trucks].GVWR)='10001-14000' Or ([Diesel Trucks].GVWR)='14001-16000' Or
([Diesel Trucks].GVWR)='16001-19000' Or ([Diesel Trucks].GVWR)='16001-
19500' Or ([Diesel Trucks].GVWR)='19001-26000' Or ([Diesel
Trucks].GVWR)='19501-26000' Or ([Diesel Trucks].GVWR)='26001-33000' Or
([Diesel Trucks].GVWR)='33001-40000'));

Result: 6031

Create Distribution for **HDGV**
SELECT HDGV.VIN, HDGV.Make, HDGV.ModelYear, HDGV.Fuel, HDGV.VINVIN,
HDGV.VINYear, HDGV.VINMake, HDGV.VINSeries, HDGV.VINBody,
HDGV.VINmanuf, HDGV.VINType, HDGV.GVWR
FROM HDGV
WHERE (((HDGV.ModelYear)<=1975));

Create Distribution for **HDDV**
```
SELECT HDDV.VIN, HDDV.Make, HDDV.ModelYear, HDDV.Fuel, HDDV.VINVIN,
HDDV.VINYear, HDDV.VINMake, HDDV.VINSeries, HDDV.VINBody,
HDDV.VINmanuf, HDDV.VINType, HDDV.GVWR
FROM HDDV
WHERE (((HDDV.ModelYear)<=1975));
```

Create the table **Motorcycles**

```
99-Reg-Mid1-MC = 28,458
99-Reg-Mid2-MC = 886 Records
99-Reg-Mid3-MC = 11,771 Records
99-Reg-Mid4-MC = 938 Records
```

```
SELECT [Cycles & Scooters].VIN, [Cycles & Scooters].CTYCODE, [Cycles &
Scooters].VEHYEAR, [Cycles & Scooters].VEHMAKE, [Cycles &
Scooters].VEHMODEL, [Cycles & Scooters].VEHBODY
FROM [Cycles & Scooters]
WHERE ((([Cycles & Scooters].VEHBODY)='MC')) OR ((([Cycles &
Scooters].VEHBODY)='MP')) OR ((([Cycles & Scooters].VEHBODY)='MC')) OR
((([Cycles & Scooters].VEHBODY)='MS')) OR ((([Cycles &
Scooters].VEHBODY)='MB')) OR ((([Cycles & Scooters].VEHBODY)='MP'));
```

Result: 45,679

Creating **Motorcycle** Distribution
```
select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='MC' and modelyear = 1999;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='MC' and modelyear = 1998;

select make, modelyear, fuel, vintype from thirteenfuel, vindata
where vin = vinvin and vintype ='MC' and modelyear = 1997;
.
.
.
etc.
```

Appendix B

Registration Distribution
Model Year Ending June 1999

Light Duty Gas Vehicles (Cars)	1	2	3	4	5	6	7	8	9	10
	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
LDGV 1-10			0	0	0	0	0	0	0	0
	11	12	13	14	15	16	17	18	19	20
	1988	1987	1986	1985	1884	1983	1982	1981	1980	1979
LDGV 11-20	0	0	0	0	0	0	0	0	0	0
	21	22	23	24	25					
	1978	1977	1976	1975	1974					
LDGV 21-25	0	0	0	0	0	Sum of the distribution values =			**0**	

Light Duty Diesel Vehicles (Cars)	1	2	3	4	5	6	7	8	9	10
	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
LDDV 1-10	0	0	0	0	0	0	0	0	0	0
	11	12	13	14	15	16	17	18	19	20
	1988	1987	1986	1985	1884	1983	1982	1981	1980	1979
LDDV 11-20	0	0	0	0	0	0	0	0	0	0
	21	22	23	24	25					
	1978	1977	1976	1975	1974					
LDDV 21-25		0	0	0	0	Sum of the distribution values =			**0**	

Combined Distribution LDGV/LDDV	1	2	3	4	5	6	7	8	9	10
	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
LDGV/LDDV 1-10	74340	122483	139697	156683	183344	149563	139235	116846	113180	112243
	0.035284	0.058135	0.066305	0.074367	0.08702	0.07099	0.06609	0.0555	0.053719	0.0532746
	1989	1988	1987	1986	1985	1884	1983	1982	1981	1980
LDGV/LDDV 11-20	118439	113880	103996	92472	77913	61944	40295	27663	22859	19897
	0.056215	0.054052	0.04936	0.043891	0.03698	0.0294	0.01913	0.0131	0.01085	0.0094438
	1979	1978	1977	1976	<=1975					
LDGV/LDDV 21-25	16930	14419	11315	8421	68818	Sum of the distribution values =			**2106875**	2106875
	0.008036	0.006844	0.005371	0.003997	0.03266	Sum of the distribution values =			**1**	

					Registration Distribution					
					Model Year Ending June 1999					

Light Duty Gasoline Trucks 1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
GVWR 0 - 6000 Pounds	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**
LDGT1V 1-10	0	0	0	0	0	0	0	0	0	0
	11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
	1988	**1987**	**1986**	**1985**	**1884**	**1983**	**1982**	**1981**	**1980**	**1979**
LDGT1 11-20	0	0	0	0	0	0	0	0	0	0
	21	**22**	**23**	**24**	**25**					
	1978	**1977**	**1976**	**1975**	**1974**					
LDGT1 21-25	0	0	0	0	0	**Sum of the distribution values =**			**0**	

Light Duty Gasoline Trucks 2	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
GVWR 6001 - 8500 Pounds	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**
LDGT2 1-10	18743	22378	22875	20777	21877	16655	9035	6963	4430	5514
	0.09758	0.1165	0.11909	0.108168	0.113895	0.086708	0.047037	0.03625	0.023063	0.0287066
	1989	**1988**	**1987**	**1986**	**1885**	**1984**	**1983**	**1982**	**1981**	**1980**
LDGT2 11-20	6427	5847	5054	5490	5090	4554	3016	1757	1100	403
	0.03346	0.03044	0.026312	0.028582	0.026499	0.023709	0.015702	0.009147	0.005727	0.0020981
	1979	**1978**	**1977**	**1976**	**<=1975**					
LDDV 21-25	1219	541	454	335	1547	**Sum of the distribution values =**			**192081**	192081
	0.00635	0.00282	0.002364	0.001744	0.008054	**Sum of the distribution values =**			**1**	

Combined Distribution LDGT1/LDDT	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Trucks,Diesel, 0-8500lbs	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**
LDGT1/LDDT 1-10	23971	55571	54591	54170	52316	50636	45897	31828	29173	26012
	0.04003	0.0928	0.091165	0.090462	0.087366	0.08456	0.076646	0.053152	0.048718	0.0434391
	1989	**1988**	**1987**	**1986**	**1885**	**1984**	**1983**	**1982**	**1981**	**1980**
LDGT1/LDDT 11-20	29553	29081	21655	19415	16411	12003	7887	5297	4708	2124
	0.04935	0.04856	0.036163	0.032422	0.027406	0.020045	0.013171	0.008846	0.007862	0.003547
	1979	**1978**	**1977**	**1976**	**<=1975**					
LDGT1/LDDT 21-25	3337	4175	3347	2537	13120	**Sum of the distribution values =**			**598815**	598815
	0.00557	0.00697	0.005589	0.004237	0.02191	**Sum of the distribution values =**			**1**	

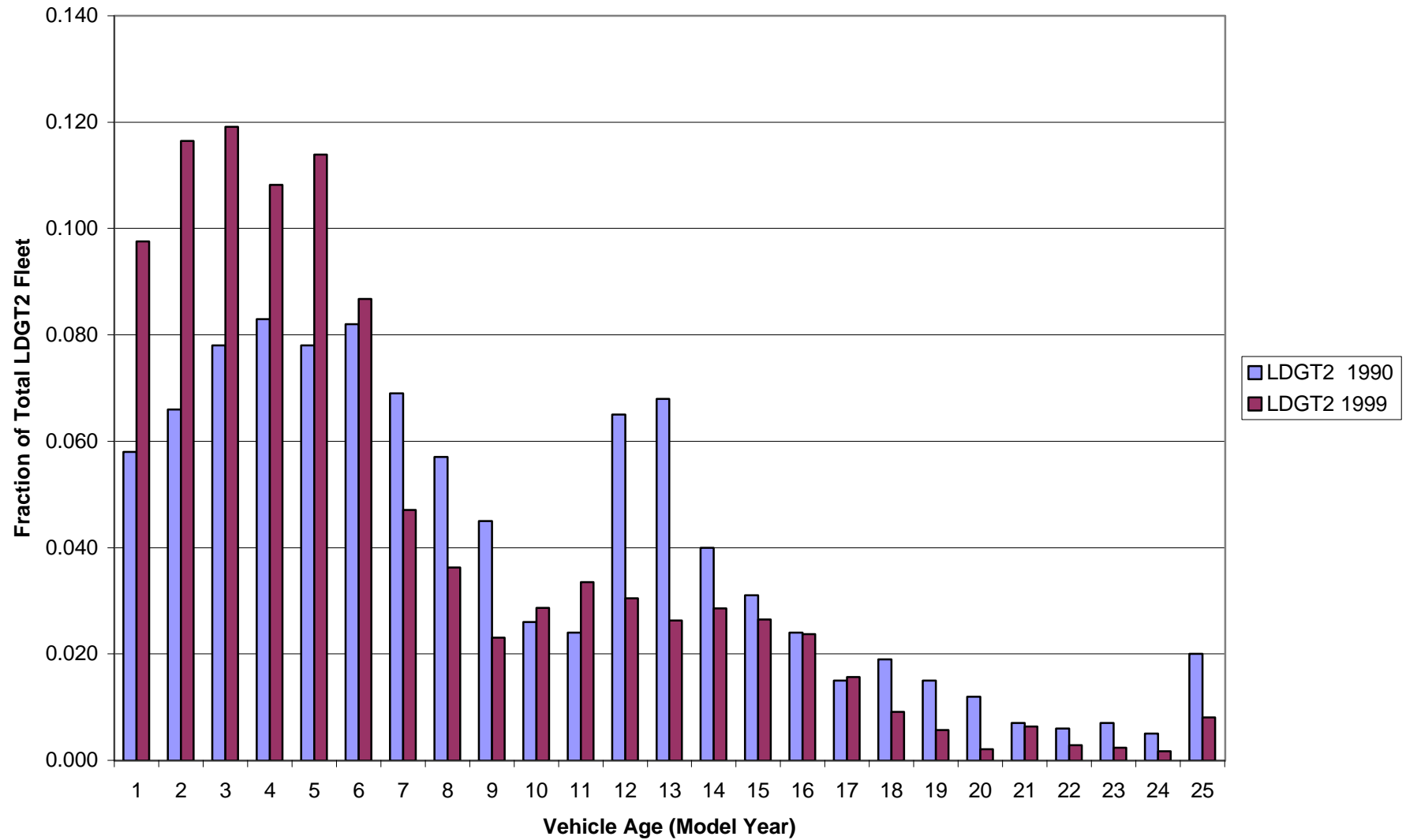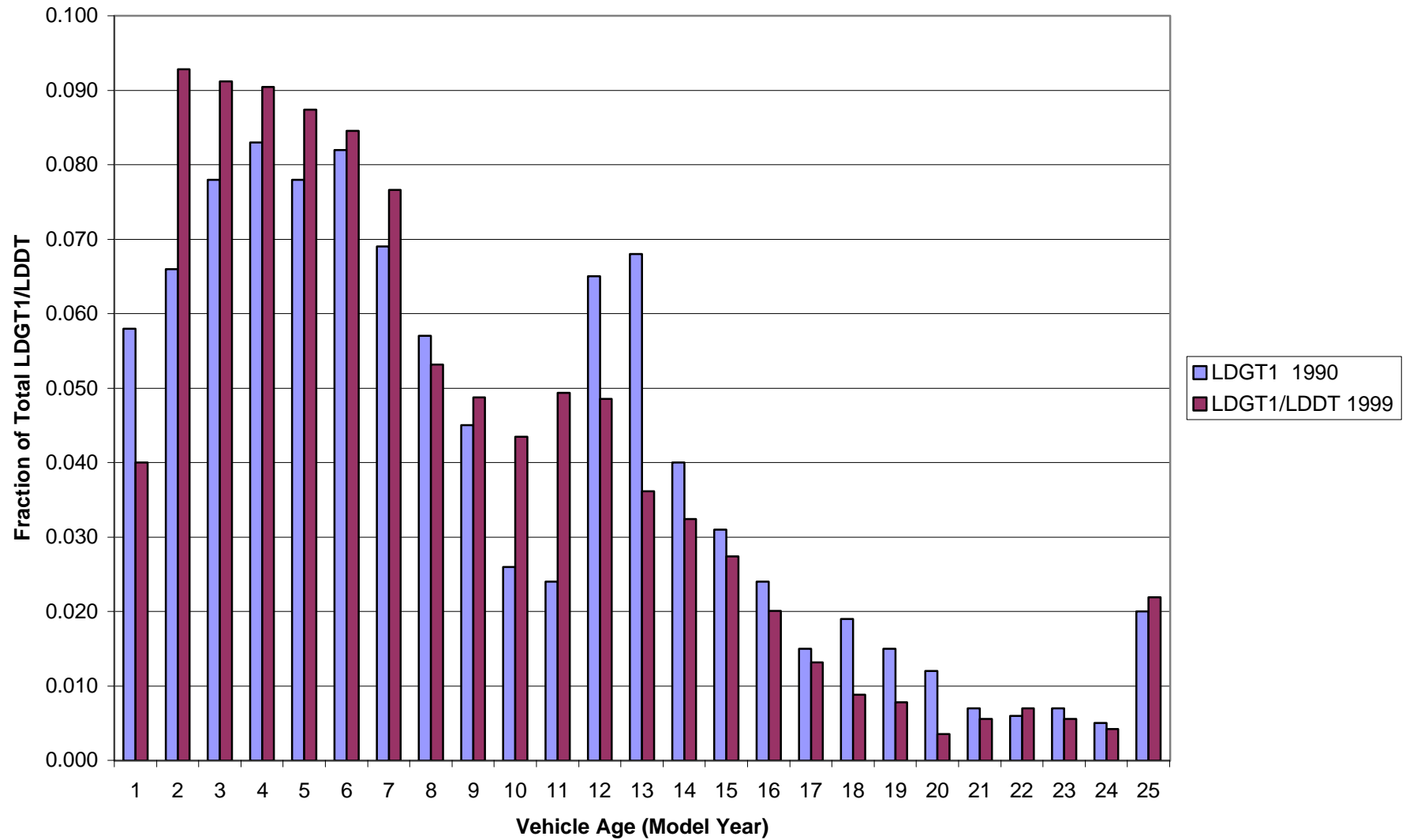|				Registration Distribution							Page 3 of 3
				Model Year Ending June 1999							
HDGV											
Heavy Duty Gasoline Trucks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
GVWR >8500 Pounds	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**	
HDGV 1-10	3274	3128	4136	4065	4369	3461	2394	1857	1545	1738	
	0.065425	0.062507	0.082651	0.081232	0.087307	0.069162	0.04784	0.037109	0.03087	0.03473083	
	1989	**1988**	**1987**	**1986**	**1885**	**1984**	**1983**	**1982**	**1981**	**1980**	
HDGV 11-20	2083	2060	1569	2086	1936	1681	1081	878	682	641	
	0.041625	0.041165	0.031354	0.041685	0.038688	0.033592	0.0216	0.017545	0.01363	0.01280924	
	1979	**1978**	**1977**	**1976**	**<=1975**						
HDGV 21-25	1038	742	570	398	2630	Sum of the distribution values =			**50042**	50042	
	0.020743	0.014828	0.01139	0.007953	0.052556	Sum of the distribution values =			**1**		
HDDV											
Heavy Duty Diesel Vehicles Trucks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
GVWR > 8500 Pounds	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**	
HDDV 1-10	336	318	865	638	744	525	349	193	162	148	
	0.055712	0.052728	0.143426	0.105787	0.123363	0.08705	0.05787	0.032001	0.02686	0.02453988	
	1989	**1988**	**1987**	**1986**	**1885**	**1984**	**1983**	**1982**	**1981**	**1980**	
HDDV 11-20	236	150	146	208	173	133	63	47	3	166	
	0.039131	0.024871	0.024208	0.034488	0.028685	0.022053	0.01045	0.007793	0.0005	0.02752446	
	1979	**1978**	**1977**	**1976**	**<=1975**						
HDDV 21-25	134	88	73	37	96	Sum of the distribution values =			**6031**	6031	
	0.022219	0.014591	0.012104	0.006135	0.015918	Sum of the distribution values =			**1**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Motorcycles	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**	
MC 1-10	1450	2917	3187	3394	2849	2619	2396	1496	1094	1062	
	0.031743	0.063859	0.069769	0.074301	0.06237	0.057335	0.05245	0.03275	0.02395	0.0232492	
	1989	**<=1988**	**1987**	**1986**	**1985**	**1884**	**1883**	**1982**	**1981**	**1980**	
MC 11-20	1065	22150	0	0	0	0	0	0	0	0	
	0.023315	0.484906	0	0	0	0	0	0	0	0	
	1979	**1978**	**1977**	**1976**	**<=1975**						
MC 21-25	0	0	0	0	0	Sum of the distribution values =			**45679**	45679	
	0	0	0	0	0	Sum of the distribution values =			**1.00**		

Appendix C

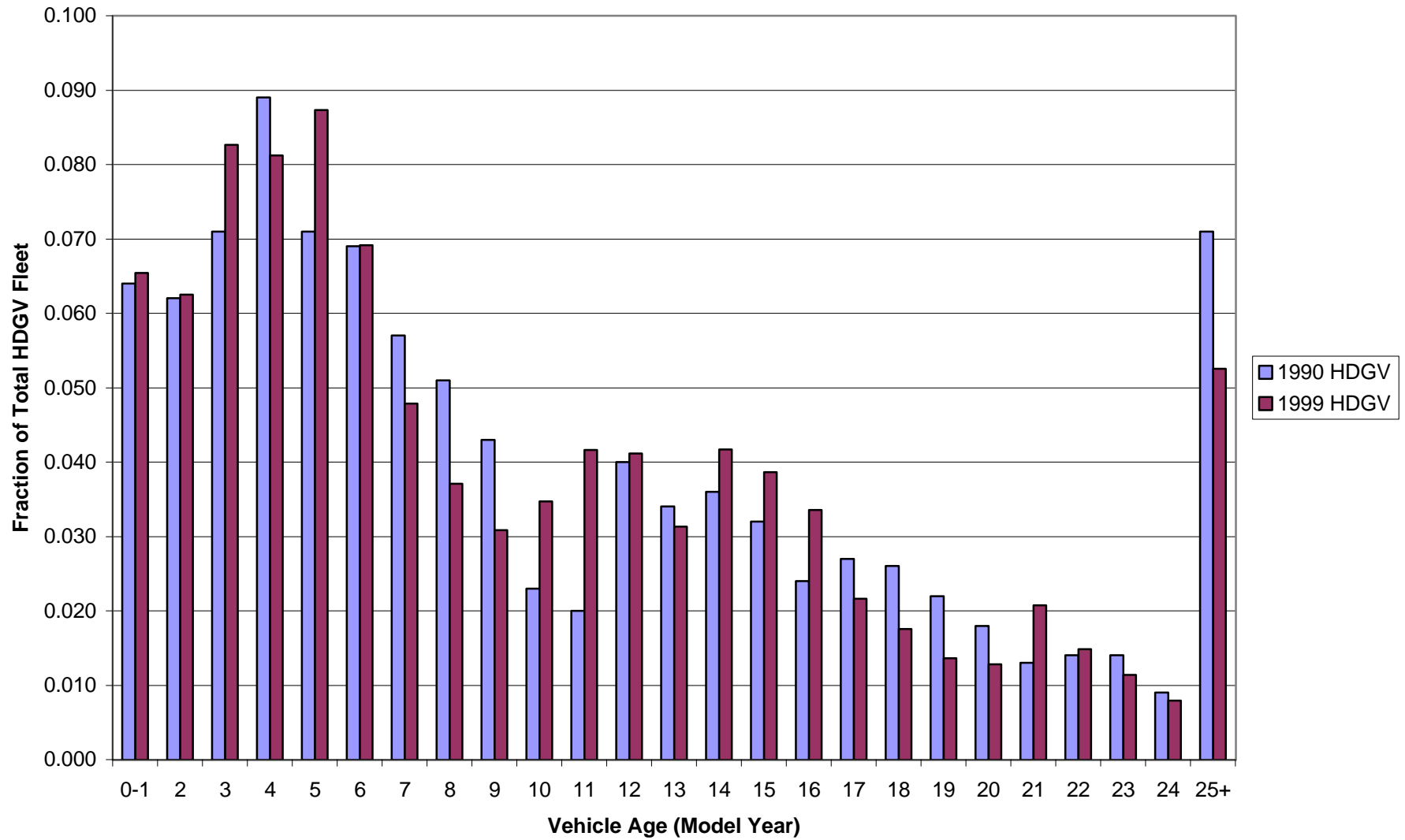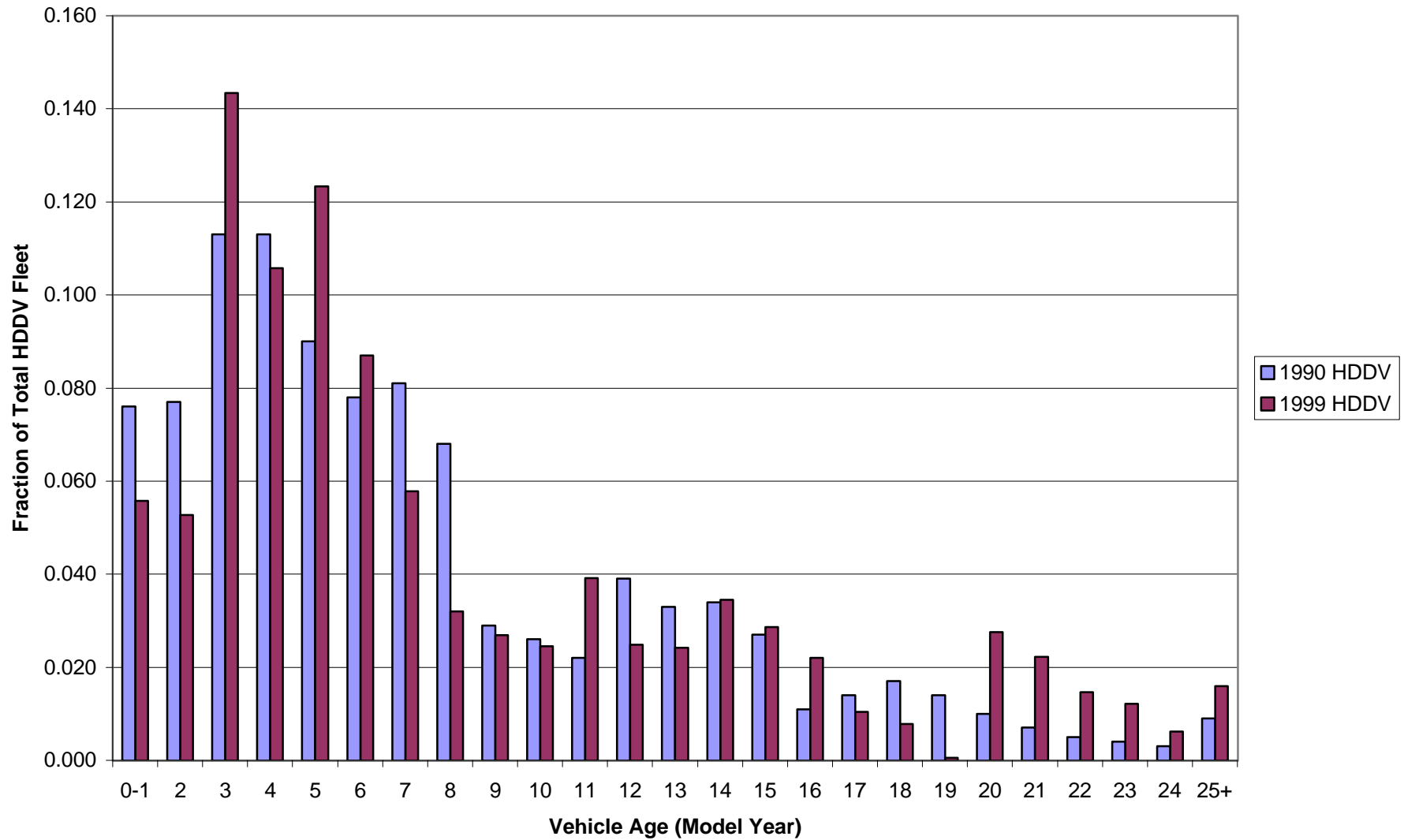LDGV_LDDV (Passenger Cars) 1990 vs 1999
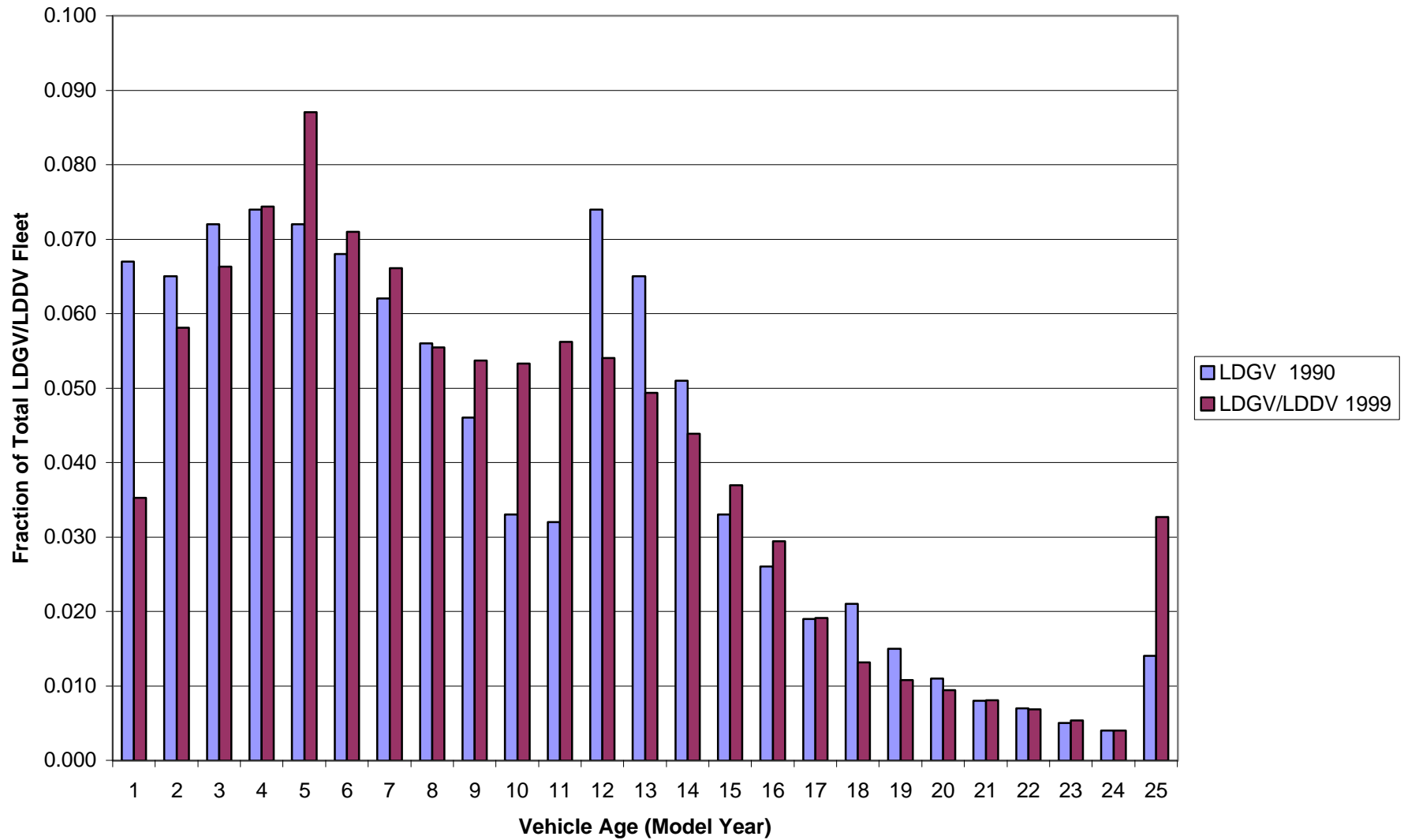
LDGT2 1990 vs 1999

LDGT1/LDDT 1999 vs LDGT1 1990

Figure: Bar chart showing Fraction of Total LDGT1/LDDT versus Vehicle Age (Model Year), comparing LDGT1 1990 and LDGT1/LDDT 1999.

HDGV 90 vs 99

HDDV 90 vs 99

Motorcycles

Fraction of Total MC Fleet (y-axis), Vehicle Age (Model Year) (x-axis)

Legend: MC 1990, MC 1999